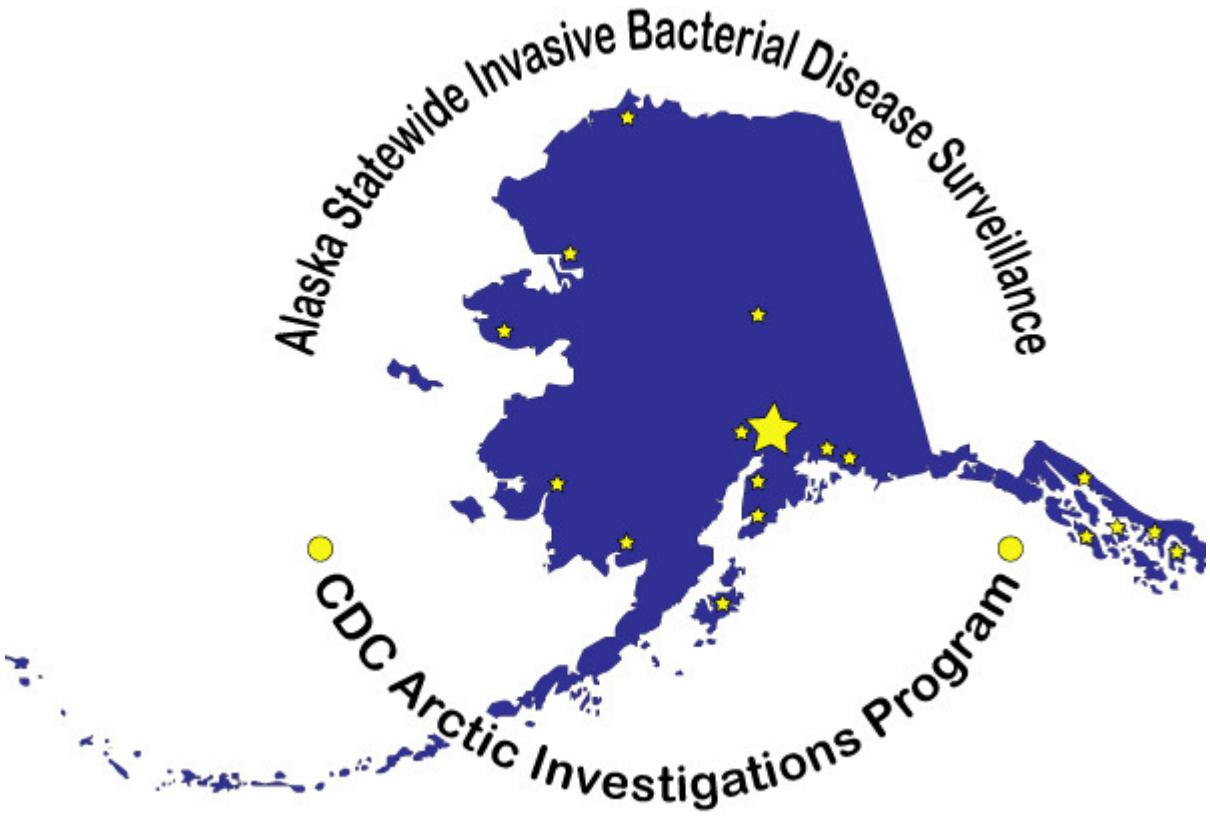

Surveillance of Invasive Bacterial Disease in Alaska, 2010

Arctic Investigations Program
National Center for Emerging & Zoonotic Infectious Diseases
Centers for Disease Control and Prevention
4055 Tudor Centre Dr.
Anchorage, AK 99508
(907) 729-3400
ncidaip@cdc.gov

Alaska Statewide Invasive Bacterial Disease

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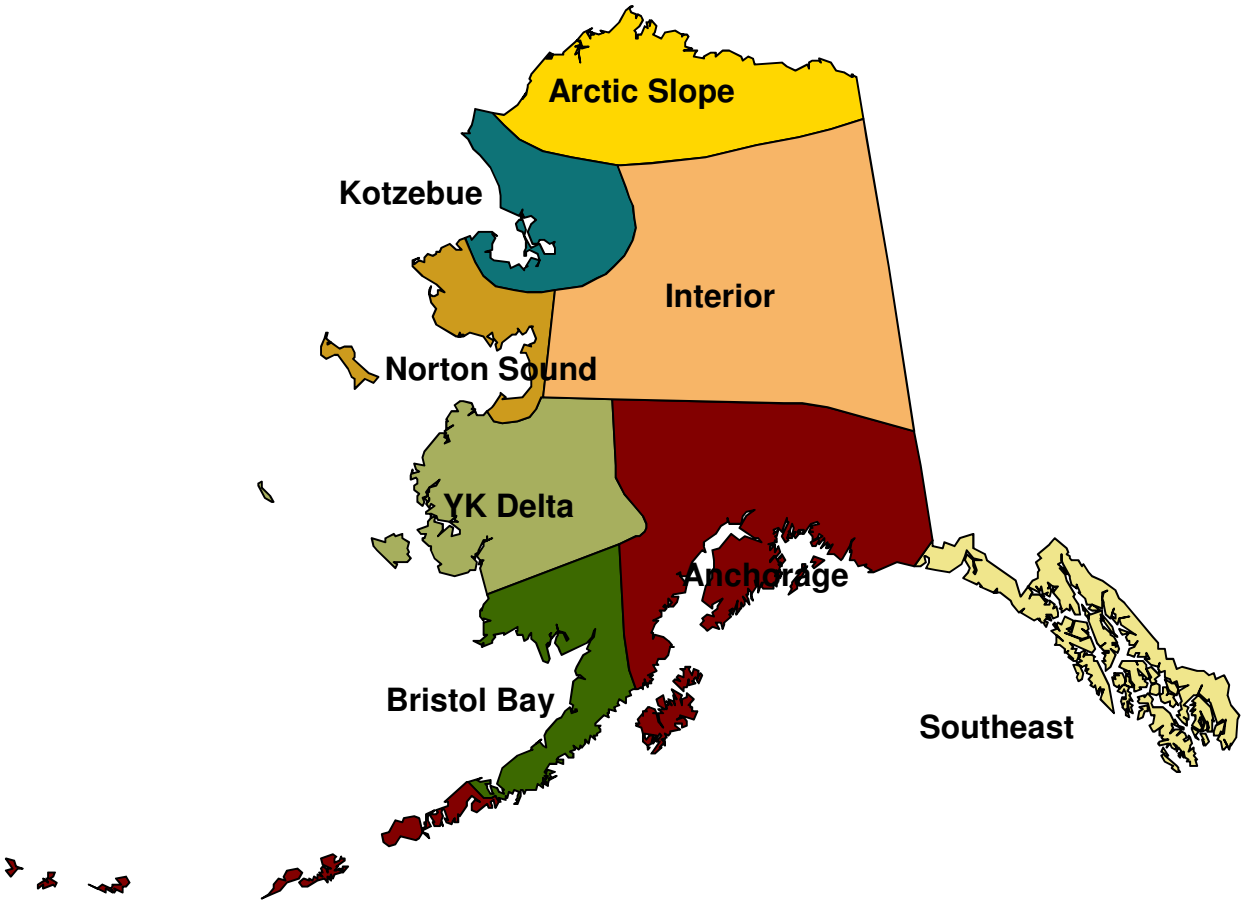
Summary

The Centers for Disease Control and Prevention's Arctic Investigations Program (AIP) in Anchorage, Alaska, maintains a statewide surveillance system for invasive diseases caused by *Streptococcus pneumoniae*, *Haemophilus influenzae, Neisseria meningitidis,* and groups A and B streptococci. Laboratories throughout the state are requested to send to AIP any isolates of these organisms recovered from a blood culture, CSF, or other normally sterile site in an Alaska resident. Isolate identification is confirmed and, when appropriate, serotyped and tested for antimicrobial susceptibility. The objectives of this system are to provide information on disease rates within the state, monitor the emergence of antimicrobial resistance, and to monitor the effectiveness of implemented vaccine programs, such as the 23-valent pneumococcal polysaccharide vaccine, the pneumococcal conjugate vaccine and *Haemophilus influenzae* type b vaccines.

Figure 1: Invasive Bacterial Disease Surveillance Regions – Alaska, 2010



In 2010, the total numbers of cases of invasive disease caused by these organisms reported to AIP were 115 *S. pneumoniae*, 29 *H. influenzae*, 1 *N. meningitidis*, 42 group A *Streptococci* (GAS) and 53 group B *Streptococci* (GBS). Alaska Native people had higher rates of disease overall than non-Native people

for all surveillance organisms. Rates of invasive pneumococcal disease were highest in the YK Delta and Bristol Bay. Rates for each organism by region are presented in the following table.

Table 1: Surveillance Organisms Reported by Region – Alaska, 2010

Region	*S. pneumoniae* n (rate*)	*H. influenzae* n (rate*)	*N. meningitidis* n (rate*)	GAS n (rate*)	GBS n (rate*)
Anchorage	61 (13)	7 (1.5)	1 (1.5)	26 (5.5)	42 (9)
Arctic Slope	2 (23.7)	0 (0)	0 (0)	1 (11.9)	2 (23.7)
Bristol Bay	4 (56.2)	1 (14.1)	0 (0)	0 (0)	0 (0)
Interior	19 (17.1)	4 (3.6)	0 (0)	5 (4.5)	1 (0.9)
Kotzebue	1 (12.2)	3 (36.6)	0 (0)	0 (0)	0 (0)
Norton Sound	4 (42.1)	2 (21.1)	0 (0)	1 (10.5)	0 (0)
Southeast	10 (14)	1 (1.4)	0 (0)	6 (8.4)	5 (7)
YK Delta	14 (56.7)	11 (44.5)	0 (0)	3 (12.1)	3 (12.1)
Total	115 (16.2)	29 (4.1)	1 (0.1)	42 (5.9)	53 (7.5)

*Cases per 100,000 population

Introduction

AIP conducts statewide surveillance of invasive *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, and groups A and B *Streptococcus*. This program is part of a passive, laboratory-based surveillance system in which laboratories from all hospitals throughout the state are encouraged to participate. The population included in the AIP surveillance is the State of Alaska, which totaled 710,231 persons in 2010 [1]. Case detection occurs year-round as participating laboratories send isolates recovered from sterile sites to the AIP laboratory in Anchorage, accompanied by basic demographic and clinical information on the cases. Materials and forms for isolate shipment and data collection are provided to each laboratory by AIP. At year-end, AIP asks that each laboratory review their records and provide information on any cases that may have been overlooked. In 2010, 23 laboratories in Alaska participated in the invasive disease surveillance system, either by sending isolates to the AIP laboratory throughout the year, conducting year-end record reviews, or both. Beginning in January, 2007, invasive *S. pneumoniae*, GAS and GBS became reportable conditions to the State of Alaska Division of Public Health (DPH). Reports of cases of disease caused by these organisms, along with cases of invasive *H. influenzae* and *N. meningitidis* which were previously reportable, are shared between AIP and DPH.

AIP defines a case of invasive *S. pneumoniae, H. influenzae*, *N. meningitidis*, GAS or GBS as an isolate of the bacteria from a normally sterile site, including blood, cerebrospinal fluid, pleural fluid, peritoneal fluid or joint fluid that has been taken from a resident of Alaska. In addition, for GAS, isolates are requested from deep tissue infections such as might be collected from surgical debridement of cases of necrotizing fasciitis.

Invasive Pneumococcal Disease

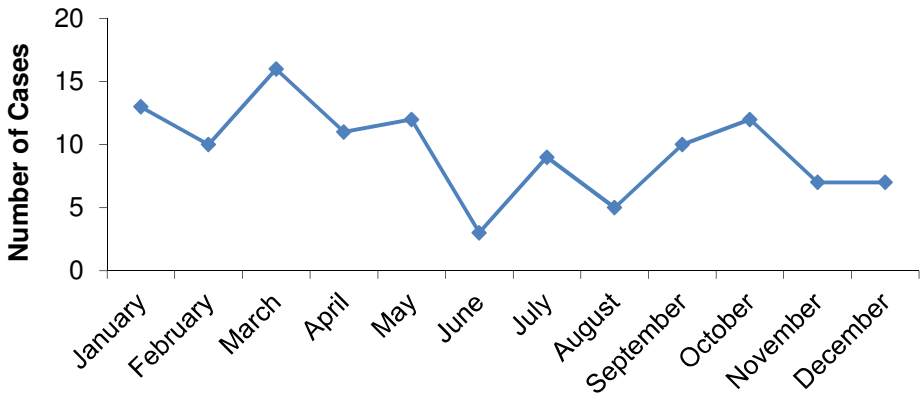
Overall Incidence

A total of 105 pneumococcal isolates were received at AIP in 2010. An additional 4 cases were detected through year-end follow up with participating laboratories and 6 cases through shared surveillance with the State DPH for a total of 115 cases of invasive pneumococcal disease. The overall rate for invasive pneumococcal disease in 2010 was 16.2 cases per 100,000 persons per year. Alaska rates for 2010 were higher than the Active Bacterial Core Surveillance (ABCs) 2010 national projected rate of 12.9/100,000 [2]. ABCs is a surveillance system operated in 10 states which covers a population of over 41 million persons.

Seasonality

Invasive *Streptococcus pneumoniae* cases were identified in each month of 2010. The largest number of cases was reported in March.

Figure 2: Invasive Pneumococcal Disease, by Month of Culture - Alaska, 2010



Race

In 2010, the state population was comprised of 19.5% Alaska Native people *(Alaska Natives 138,312, non-Natives 571,919)* [1]. Of all reported *S. pneumoniae* cases in 2010, 44% occurred among Alaska Native people for a total of 51 cases; the age-adjusted rate was 39.1/100,000 persons per year. Sixty-four cases occurred among the non-Native population for an age-adjusted rate of 10.7/100,000 persons per year. The rate ratio of age-adjusted rates of *S. pneumoniae* disease for the Alaska Native population compared with the non-Native population in 2010 was 3.7.

Table 2: Invasive *Streptococcus pneumoniae* Cases by Race – Alaska, 2010

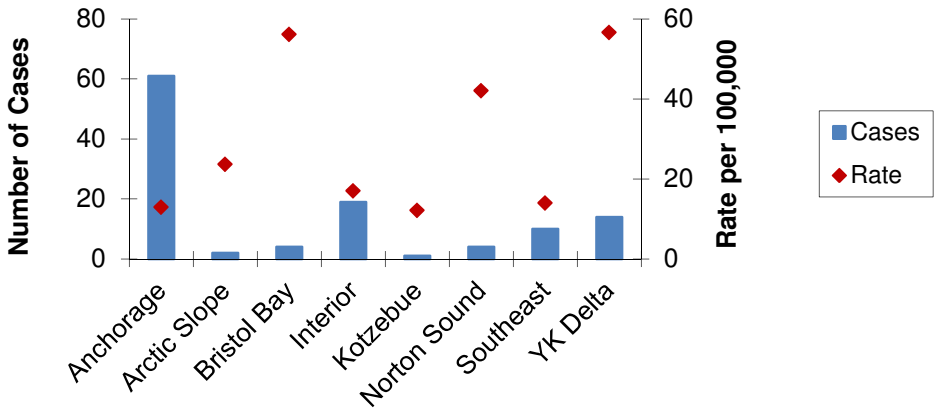
Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	51 (44)	39.1	57%	3 (5.9)
Non-Native†	64 (56)†	10.7	63.5%	9 (14.5)‡
Total	115		60%	12 (10.6)

*Cases per 100,000 per percent distribution of Alaska 2010 population
†Includes 1 case for which race was unknown
‡Outcome unknown in 2 cases

Region

The highest percentage (53%) of invasive pneumococcal disease cases occurred in the Anchorage area in 2010. Rates of disease, however, were highest in Bristol Bay (56.2/100,000 persons per year) and the YK Delta (56.7/100,000 persons per year).

Figure 3: Invasive Pneumococcal Disease, Cases & Rates by Region - Alaska, 2010

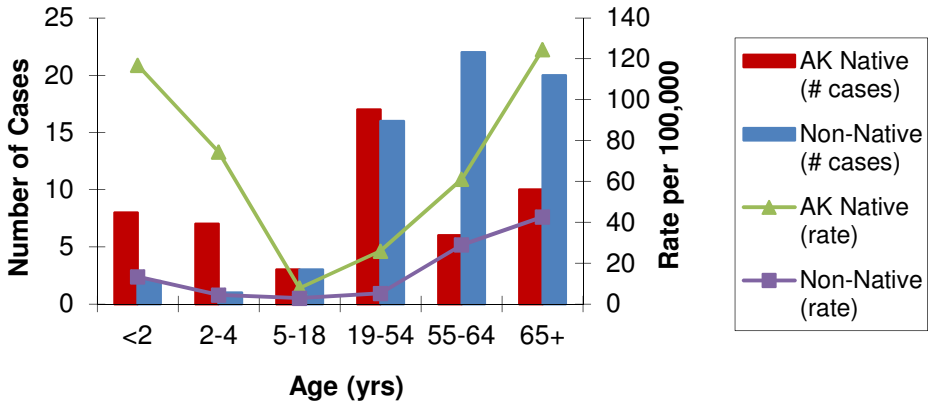


Age

Cases occurred in all age groups in 2010 ranging from 3 months to 95 years with a median age of 55 years. Overall, the highest rates of disease occurred in adults 65 years and older.

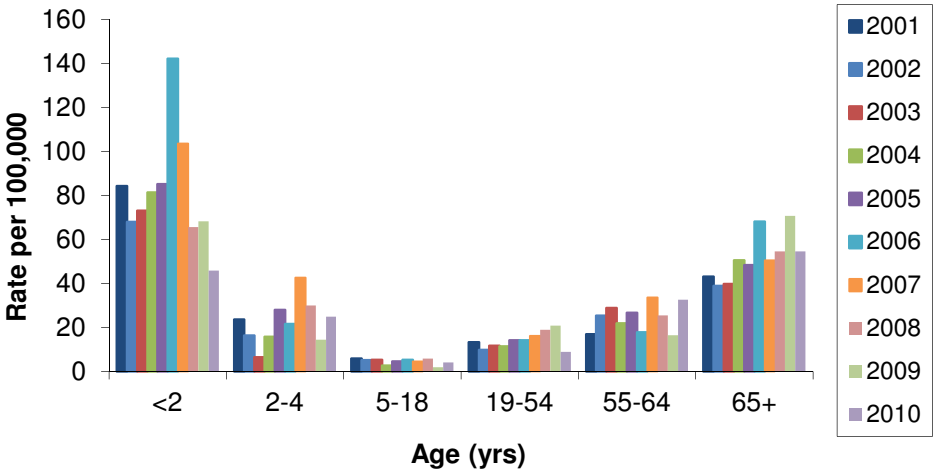
When stratified by age and race, the highest rates of disease in 2010 occurred in Alaska Native adults 65 years and older (124.6/100,000 persons per year).

Figure 4: Invasive Pneumococcal Disease, Cases & Rates by Age Group & Race - Alaska, 2010



Since the initiation of a pneumococcal 7-valent conjugate vaccine program in 2001, overall rates of invasive disease declined dramatically in children less than 2 years of age [3]. In 2002, overall yearly rates of pneumococcal disease in children less than 2 years dropped to a low of 67.9/100,000 and then increased to 142.2/100,000 in 2006. In 2008, the rate of invasive pneumococcal disease in children less than 2 years declined to 65.6/100,000 which was the lowest rate observed in this age group since introduction of the 7-valent vaccine. Following introduction of a 13-valent conjugate vaccine in 2010, rates of disease observed in children less than 2 years old declined to 45.8/100,000.

Figure 5: Invasive Pneumococcal Disease by Age Group - Alaska, 2001-2010



Although pneumococcal disease rates dropped initially in AK Native and non-Native children less than 2 years of age after introduction of the 7-valent vaccine, the rates of disease in AK Native children less than 2 years trended upward from a low of 93.6/100,000 in 2001 to 335.9/100,000 in 2006. This increase in rates was due primarily to disease caused by serotypes not contained in the pneumococcal conjugate vaccine [4,5]. In 2009, rates of disease in AK Native children less than 2 years declined to 87.1/100,000 which was the lowest rate since the introduction of the seven-valent pneumococcal vaccine. After introduction of the 13-valent vaccine in 2010, rates increased slightly to 116.9/100,000, however, this reflects only an additional two cases from 2009 and is not statistically significant (p=0.6).

Rates of invasive disease in non-Native children less than 2 years declined during the same time period reaching 26.8/100,000 in 2005, and following an increase to 64.4/100,000 in 2007, declined in 2008 to 6.2/100,000. In 2009, the rate of disease in non-Native children less than 2 years increased to 60.3/100,000, but declined to 13.3/100,000 in 2010 following introduction of the 13-valent vaccine.

Figure 6: Invasive Pneumococcal Disease in Alaska Natives, by Age Group - Alaska, 2001-2010

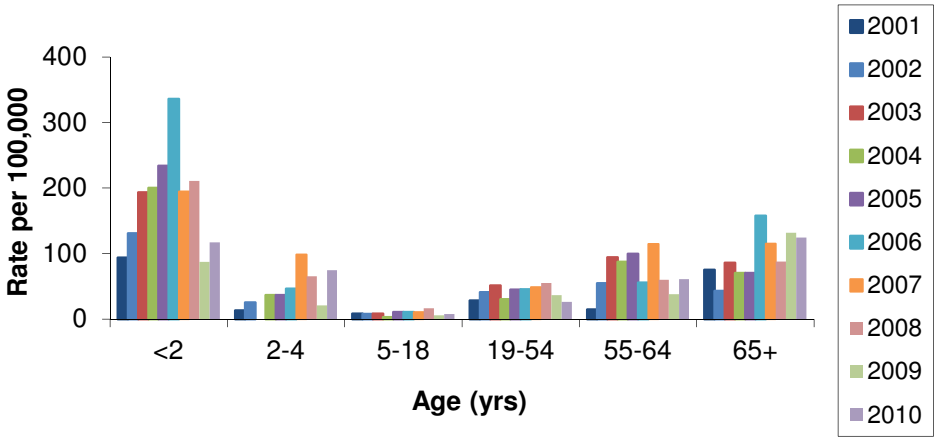
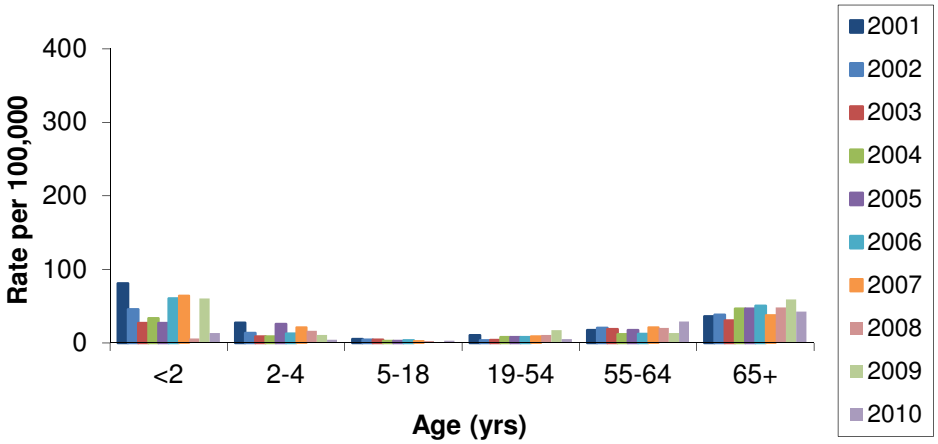


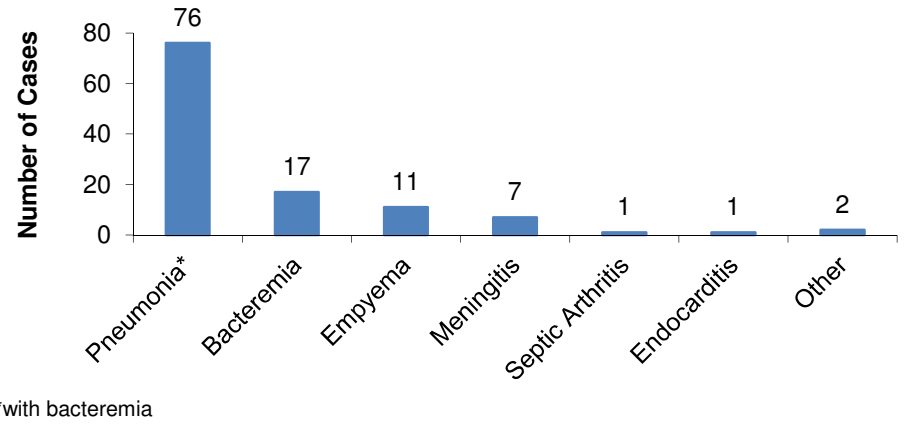
Figure 7: Invasive Pneumococcal Disease in Non-Natives, by Age Group - Alaska, 2001-2010



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the pneumococcal infection was recorded as the primary clinical presentation. Pneumonia with bacteremia was the most common primary clinical presentation in 2010 (66%) followed by bacteremia (15%). Thirteen cases had a secondary pneumococcal-related diagnosis in 2010 - 11 pneumonia, 1 cellulitis, and 1 pericarditis.

Figure 8: Primary Clinical Presentations of Invasive Pneumococcal Disease - Alaska, 2010



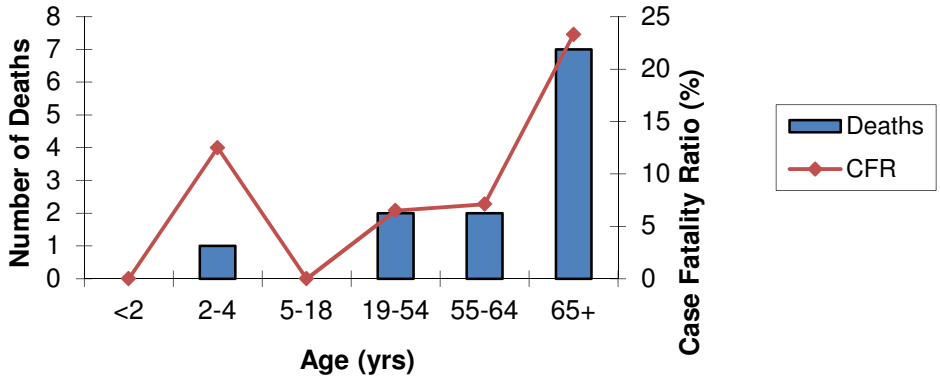
*with bacteremia

In 2010, blood was the most common source of a positive culture which was used to identify 104 (90%) of 115 cases. Cerebrospinal fluid was the positive site for 5 (4%) of cases; four cases were identified from pleural fluid and two cases from surgical specimens.

Mortality

In 2010, the overall case fatality ratio for *S. pneumoniae* in Alaska was 10.6% (12 deaths out of 113 cases for which outcomes were known). The case fatality ratio for non-Natives was higher (14.5%, 9 deaths) than AK Natives (5.9%, 3 deaths). The majority of deaths and the highest case fatality ratio occurred in the 65+ age category (7 deaths) 23.3%.

Figure 9: Invasive Pneumococcal Deaths & Case Fatality Ratios by Age Group - Alaska, 2010



Serotype

Serotyping of invasive pneumococcal isolates is performed at AIP using internationally standardized methods. Serotype identification is based on the organism's polysaccharide capsule which is a principal virulence factor for pneumococci. This information provides a way to categorize organisms and to determine if the infection was due to a type that could be prevented by use of one of the available pneumococcal vaccines. Serotyping was performed on all of the *S. pneumoniae* cases for which an isolate was available.

Table 3: Invasive Pneumococcal Serotype Distribution by Race and Age Group – Alaska, 2010

		Alaska Native				Non-Native			
Serotype	Total n (%)	<2	2-18	19-64	65+	<2	2-18	19-64	65+
03	11 (11)	-	-	-	2	-	1	7	1
04	1 (1)	-	-	-	-	-	-	1	-
06C	2 (2)	-	-	1	1	-	-	-	-
07F	20 (20)	-	2	2	2	-	1	9	4
08	4 (4)	-	-	4	-	-	-	-	-
09N	6 (6)	-	-	3	-	-	-	3	-
10A	2 (2)	-	-	-	-	-	-	1	1
11A	4 (4)	-	-	-	3	-	-	-	1
12F	4 (4)	-	-	3	-	-	-	1	-
15A	2 (2)	-	-	1	1	-	-	-	-
15B	2 (2)	-	-	1	-	-	-	1	-
15C	2 (2)	-	-	-	-	-	1	1	-
16F	6 (6)	1	-	2	-	-	-	2	1
19A	18 (18)	7	2	-	-	1	-	6	2
19F	1 (1)	-	1	-	-	-	-	-	-
20	4 (4)	-	-	2	1	-	-	1	-
22F	2 (2)	-	-	-	-	-	-	1	1
23A	6 (6)	-	-	2	-	1	-	-	3
23B	1 (1)	-	-	-	-	-	-	1	-
29	1 (1)	-	-	-	-	-	-	-	1
31	1 (1)	-	-	-	-	-	-	1	-
35F	1 (1)	-	1	-	-	-	-	-	-
38	1 (1)	-	-	-	-	-	-	-	1
Total	102	8	6	21	10	2	3	36	16

In 2010, the most common pneumococcal serotypes were 7F (20 isolates, 20%) and 19A (18 isolates, 18%). From 1986 through 2001, serotype 14 was the most common invasive pneumococcal serotype ranging from 7.4% to 23.5% of isolates. Following introduction in 2001 of the pneumococcal conjugate vaccine which includes serotype 14, the proportion of serotype 14 isolates dropped to 1.5% of serotyped isolates in 2006, did not cause any invasive pneumococcal disease in 2007 or 2008, one case in 2009 and no cases in 2010. Disease caused by serotypes 7F and 19A, which are not included in the 7-valent conjugate vaccine, continually increased until the introduction of the 13-valent vaccine in 2010 which does include these two serotypes. It is anticipated that the number of cases of invasive pneumococcal disease caused by serotypes 7F and 19A will continue to decline as vaccine coverage increases statewide. The majority (70%) of serotype 7F cases and serotype 19A cases (56%) occurred in the Anchorage area in 2010.

Table 4: Invasive Pneumococcal Serotype Distribution by Region – Alaska, 2010

Serotype	Anchorage	Arctic Slope	Bristol Bay	Interior	Kotzebue	Norton Sound	Southeast	YK Delta
03	8	-	-	1	-	1	-	1
04	1	-	-	-	-	-	-	-
06C	1	-	-	-	-	-	1	-
07F	14	1	-	2	-	1	1	1
08	-	-	-	2	-	1	-	1
09N	3	-	-	3	-	-	-	-
10A	1	-	-	1	-	-	-	-
11A	2	-	1	1	-	-	-	-
12F	-	-	-	1	-	-	-	3
15A	-	-	-	1	-	-	1	-
15B	-	-	-	2	-	-	-	-
15C	2	-	-	-	-	-	-	-
16F	3	-	-	1	1	-	-	1
19A	10	-	2	-	-	-	2	4
19F	1	-	-	-	-	-	-	-
20	2	-	-	-	-	-	-	2
22F	2	-	-	-	-	-	-	-
23A	3	-	-	2	-	-	1	-
23B	-	-	-	1	-	-	-	-
29	1	-	-	-	-	-	-	-
31	1	-	-	-	-	-	-	-
35F	1	-	-	-	-	-	-	-
38	1	-	-	-	-	-	-	-
Total	57	1	3	18	1	3	6	13

Vaccine Serotypes

Two different vaccines were licensed for prevention of pneumococcal disease in children in 2010. In 2001, the pneumococcal conjugate vaccine (PCV7) was included in the Alaska childhood vaccination schedule. This vaccine provides protection against the 7 most common pneumococcal serotypes causing invasive disease among children (types 4, 6B, 9V, 14, 18C, 19F, 23F). In early 2010, a new pneumococcal conjugate vaccine (PCV13) was introduced into the Alaska childhood vaccination schedule. This vaccine provided protection against the 7 pneumococcal serotypes contained in the PCV7 vaccine plus six additional serotypes (1, 3, 5, 6A, 7F, 19A) that have caused invasive disease since the introduction of the PCV7 vaccine. The tables below show the proportion of invasive infections from 2010 that were due to serotypes found in the PCV7 or the PCV13 vaccine. There was one case of pneumococcal disease caused by serotypes contained in the PCV7 vaccine in children less than 5 years of age, the age group for which the vaccine is recommended. Ten of the 15 cases of pneumococcal disease in children less than 5 years old were caused by serotypes in the PCV13 vaccine. It is anticipated that the number of cases caused by these serotypes will decrease as coverage by this vaccine increases over time.

Table 5: Proportion of Invasive Isolates Contained in the PCV7 Vaccine by Age Group and Race – Alaska, 2010

Age (yrs)	Alaska Native (%)	Non-Native (%)	Total (%)
<2	0 (0%) of 8	0 (0%) of 2	0 (0%) of 10
2-4	1 (25%) of 4	0 (0%) of 1	1 (20%) of 5
5+	0 (0%) of 33	1 (2%) of 54	1 (1%) of 87
Total	1 (2%) of 45	1 (2%) of 57	2 (2%) of 102

Table 5a: Proportion of Invasive Isolates Contained in the PCV13 Vaccine (6 Serotypes not in PCV7) by Age Group and Race – Alaska, 2010

Age (yrs)	Alaska Native (%)	Non-Native (%)	Total (%)
<2	7 (87.5%) of 8	1 (50%) of 2	8 (80%) of 10
2-4	2 (50%) of 4	0 (0%) of 1	2 (40%) of 5
5+	8 (24%) of 33	31 (57%) of 54	39 (45%) of 87
Total	17 (38%) of 45	32 (56%) of 57	49 (48%) of 102

For the year covered by this report, the 23-valent polysaccharide vaccine (Ps23V) was recommended in Alaska for all persons 65 years and older, and for persons over age 2 who are at higher risk for pneumococcal disease [5]. In 2010, for persons 65 years and older, 18 (67%) of 27 cases serotyped were potentially vaccine preventable invasive pneumococcal illnesses.

Vaccine Failures

A PCV7 vaccine failure is defined as invasive pneumococcal disease caused by a serotype contained in the PCV7 vaccine in a child less than five years old who has had at least two doses of vaccine. There was one vaccine failure in 2010; the child was 3 years old and had a history of patent ductus arteriosus.

Potentially Preventable Deaths

In 2010, pneumococcal vaccine status was known for 66 (57%) of the 115 cases; 51 cases (77%) of cases with known vaccine statue did receive a pneumococcal vaccine prior to illness and 15 cases (23%) had no record of a pneumococcal vaccine.

Table 6: Potentially Vaccine Preventable Invasive Pneumococcal Deaths – Alaska, 2010

Serotypes	< 2 years	2-4	5-18	19-54	55-64	65+	Total
PCV7	0	0	0	0	0	0	0
PCV13	0	0	0	0	0	0	0
Ps23V	0	0	0	2 (100%)	2 (100%)	4 (57%)	8 (67%)
Non-Vaccine	0	1 (100%)	0	0	0	1 (14%)	2 (16.5%)
Unknown	0	0	0	0	0	2 (29%)	2 (16.5%)
Total	0	1	0	2	2	7	12

Overall, 67% of all pneumococcal-related mortality in 2010 was potentially preventable with the use of the 23-valent polysaccharide vaccine in persons over 2 years old; 16.5% of deaths were due to disease caused by serotypes not contained in the 23-valent vaccine.

Eight of the 12 deaths in 2010 from invasive *S. pneumoniae* occurred from serotypes contained within the Ps23V vaccine; 4 of the deaths were in individuals eligible for the vaccine. Of those four deaths,

two occurred in vaccinated individuals; time since vaccination was 10 months for one and 9 years for the second vaccinated individual.

Table 7: Invasive Pneumococcal Disease, Serotypes of Fatal Cases – Alaska, 2010

Serotype	Deaths n (%)	Serotype Frequency (n)
03‡*	3 (37.5%)	8
07F‡*	1 (5%)	20
10A*	2 (100%)	2
12F*	1 (25%)	4
15A	1 (50%)	2
19A‡*	1 (6%)	18
35F	1 (100%)	1

†Serotypes contained in the 7-valent conjugate vaccine
‡Serotypes contained in the 13-valent conjugate vaccine (6 additional serotypes only)
*Serotypes contained in the 23-valent polysaccharide vaccine

Associated Medical Conditions

The presence of one or more associated medical conditions was reported in 87% of invasive pneumococcal cases in 2010. Cigarette smoking was the most prevalent risk factor observed in adults followed by chronic lung disease and alcohol abuse.

Table 8: Associated Medical Conditions Identified in Invasive Pneumococcal Cases – Alaska, 2010*

Medical Condition/Risk Factor	Adult Cases (≥ 18 years) n=91, Cases (%)
Cigarette smoking	43 (47%)
Chronic lung disease	33 (36%)
Alcohol abuse	31 (34%)
Diabetes	23 (25%)
Immunosuppressive treatment	7 (8%)
Injection drug use	1 (1%)
Asplenia	2 (2%)

*More than one risk factor was identified in several cases

Antibiotic Resistance

Susceptibility testing was performed on 101 isolates received in 2010. Results of the testing are presented in the following table.

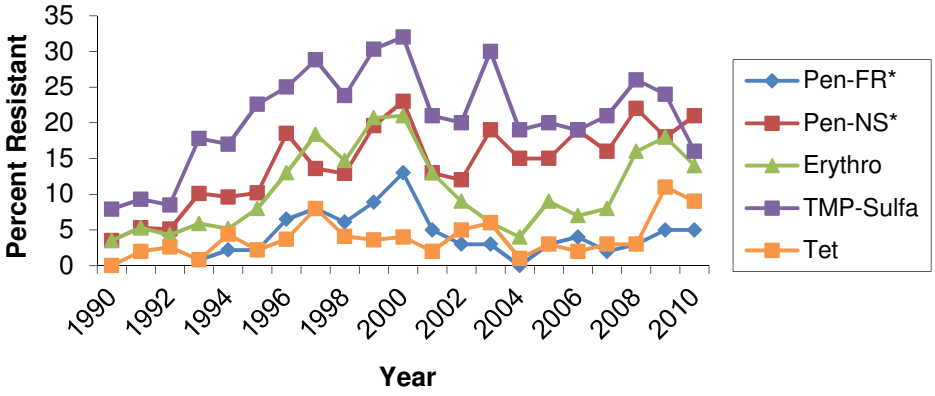
Table 9: Antibiotic Resistance in Invasive *Streptococcus pneumoniae* Isolates – Alaska, 2010

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	80 (79%)	16 (16%)	5 (5%)	21 (21%)	101
TMP-sulfa	85 (84%)	3 (3%)	13 (13%)	16 (16%)	101
Erythromycin	87 (86%)	0 (0%)	14 (14%)	14 (14%)	101
Ceftriaxone	96 (95%)	1 (1%)	4 (4%)	5 (5%)	101
Tetracycline	92 (91%)	0 (0%)	9 (9%)	9 (9%)	101
Chloramphenicol	101 (100%)	0 (0%)	0 (0%)	0 (0%)	101
Vancomycin	101 (100%)	0 (0%)	0 (0%)	0 (0%)	101
Levofloxacin	101 (100%)	0 (0%)	0 (0%)	0 (0%)	101
Clindamycin	93 (92%)	0 (0%)	8 (8%)	8 (8%)	101

Cut points from the Minimum Inhibitory Concentration (MIC) Interpretive Standards were used to determine if an isolate was 'susceptible', 'intermediate', or 'resistant' to the antibiotic being tested [6]. The MIC Interpretive Standards definitions of 'susceptible', 'intermediate', and 'resistant' can be found in the Appendix.

Serotypes found in the PCV7 and PCV13 vaccines are more likely to be non-susceptible to penicillin and erythromycin than non-vaccine serotypes. One potential benefit of the use of these vaccines was an anticipated decline in antibiotic resistance among circulating pneumococci. Following the initiation of the PCV7 vaccine in 2001, antibiotic resistance among invasive pneumococci dropped. During 2003, TMP-sulfa and penicillin resistance increased, however, following an increase in disease caused by serotype 19A. This serotype is included in the PCV13 vaccine; decreasing proportions of resistant isolates tested in 2010 may be due to the introduction of the vaccine this year.

Figure 10: Trends in Antibiotic Resistance Among Invasive Pneumococcal Isolates - Alaska, 1990 - 2010



*Pen-FR = fully resistant, Pen-NS = non-susceptible

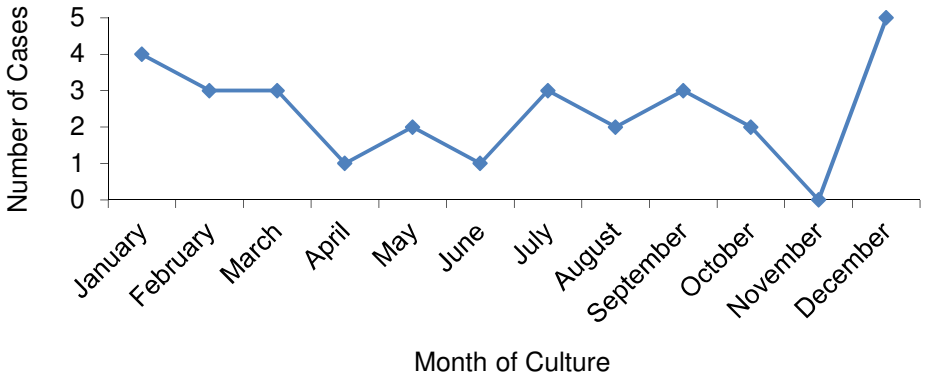
Invasive *Haemophilus influenzae*

Overall Incidence

In 2010, there were 29 cases of invasive *Haemophilus influenzae* in Alaska, for a statewide rate of 4.1/100,000 persons per year. This rate is higher than the national projected rate of 1.65/100,000 persons per year [8]. There were four deaths caused by *H. influenzae* in 2010 for a case fatality ratio of 7%.

Seasonality

Figure 11: *Haemophilus influenzae* Disease by Month of Culture - Alaska, 2010

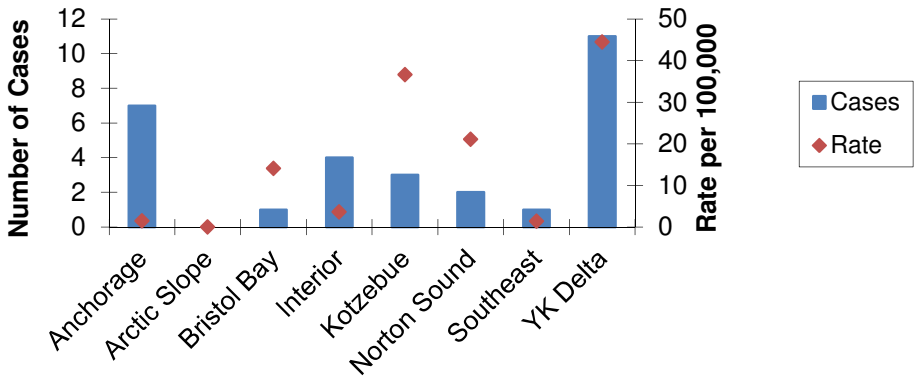


Cases of invasive *H. influenzae* occurred throughout 2010; however, due to the small number of cases, trends in seasonality cannot be determined.

Region

The highest rates of disease caused by invasive *H. influenzae* cases in 2010 were in YK Delta, 44.5/100,000 (11 cases), and Kotzebue, 36.6/100,000 (3 cases). Although a large number of cases occurred in the Anchorage area (7 cases), the rate was much lower (1.5/100,000).

Figure 12: Invasive *Haemophilus influenzae*, Cases & Rates by Region - Alaska, 2010



Race

Table 10: Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2010

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	18 (62%)	11.7	50%	2 (11%)
Non-Native	11 (38%)	1.9	73%	2 (18%)
Total	29		59%	4 (14%)

*Cases per 100,000 per percent distribution of Alaska 2010 population

In 2010, 62% of the cases occurred in Alaska Natives. Age-adjusted rates were calculated for Alaska Natives and non-Natives. The age-adjusted rate ratio of *H. influenzae* disease for the Alaska Native population compared with the non-Native population in 2010 was 6.2.

Age

H. influenzae cases ranged in age from 4 months to 90 years of age in 2010 (median 48.3 years). Overall, the highest rates of disease occurred in children less than 2 years old.

Rates of disease in Alaska Native versus non-Native populations by age group were variable; overall numbers of cases and rates by race and age group are presented in Figure 14. The highest rates of disease occurred in Alaska Native children less than two years of age, 146.1/100,000 persons per year and Alaska Native adults 65 years and older, 49.8/100,000 persons per year.

Figure 13: Invasive *Haemophilus influenzae* by Age Group - Alaska, 2010

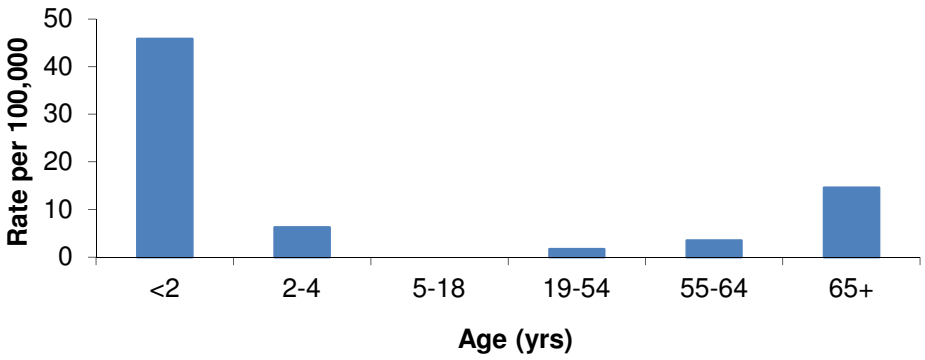
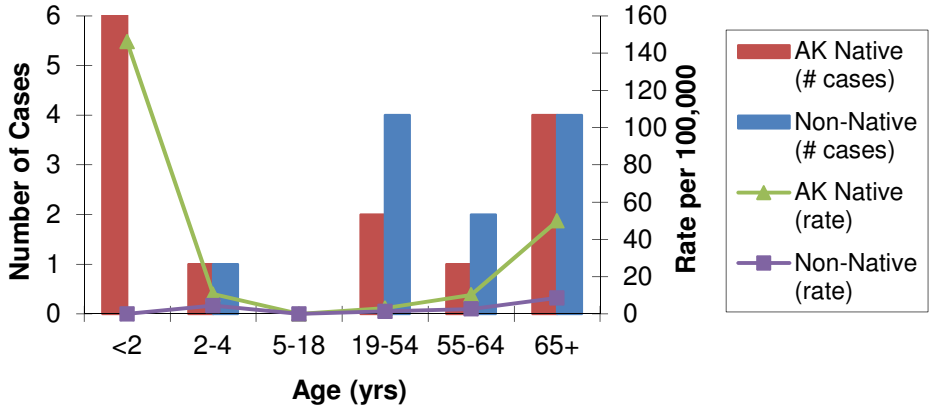


Figure 14: Invasive *Haemophilus influenzae*, Cases & Rates by Age Group & Race - Alaska, 2010



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. For cases with more than one diagnosis, the most serious *H. influenzae*-related diagnosis was recorded as the primary clinical presentation. In 2010, pneumonia with bacteremia was the most common presentation (45% of cases).

Twenty-five (86%) of *H. influenzae* isolates were from blood samples in 2010, one each was from pleural and synovial fluid and two cases of *H. influenzae* were identified by polymerase chain reaction from serum and pleural fluid.

Table 11: Primary Clinical Presentation of Invasive *Haemophilus influenzae* - Alaska, 2010

Primary Presentation	n (%)
Pneumonia*	13 (45%)
Bacteremia	5 (17%)
Meningitis	4 (14%)
Septic arthritis	4 (14%)
Empyema	2 (7%)
Cellulitis	1 (3%)
Total	29

*with bacteremia

Serotypes

All isolates received at AIP are serotyped; 25 of the 29 cases in 2010 had isolates and were serotyped. Two cases were also identified and serotyped using PCR technology (2 serotype a cases). The bacterial capsule is the basis for serotyping and is the primary virulence factor. Serotype b was the most common serotype in the past, but its prevalence has decreased with use of the childhood Hib vaccine. Surveillance of serotypes is important for monitoring vaccine effectiveness and emergence of non-vaccine serotypes.

Table 12: Serotypes of Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2010

		Alaska Native				Non-Native			
Serotype	Total n (%)	<2	2-18	19-64	65+	<2	2-18	19-64	65+
a	9	8	0	0	0	0	0	1	0
b	3	2	0	0	1	0	0	0	0
f	3	0	0	0	1	0	1	1	0
NT*	12	0	1	3	2	0	0	3	3
Total	27	10	1	3	4	0	1	5	3

*Non-typable

Hib

In recent years, the prevalence of *H. influenzae* type b has declined due to increased use of a childhood vaccine against this serotype. Three cases of Hib occurred in 2010, one in an older adult, one in an unvaccinated child and one in a vaccinated child. Both children were under the age of 2 years; the vaccinated child had received three doses of the PedVaxHib vaccine.

Antibiotic Resistance

Twenty five *Haemophilus influenzae* isolates received at AIP were tested for susceptibility to chloramphenicol, ceftriaxone and TMP/sulfa. All 25 isolates were susceptible to chloramphenicol and ceftriaxone; 14 isolates were fully resistant to TMP/sulfa, 7 had intermediate resistance and 4 were susceptible.

Table 13: Summary of Invasive *Haemophilus influenzae* Case Characteristics, Alaska, 2010

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Medical Conditions	Survived
F	0.3	AK Native	Other	Blood	Meningitis, pneumonia	a	None	Yes
F	0.6	AK Native	Other	Blood	Septic arthritis, cellulitis	a	None	Yes
M	0.7	AK Native	Other	PCR	Bacteremia	a	Chronic lung disease	No
F	0.7	AK Native	Other	Blood	Meningitis	a	None	Yes
F	0.8	AK Native	Other	PCR	Empyema, pneumonia	a	None	Yes
F	0.9	AK Native	Other	Blood	Septic arthritis	a	None	Yes
M	1.1	AK Native	Other	Synovial fluid	Septic arthritis	b	None	Yes
F	1.2	AK Native	Other	Blood	Meningitis	a	None	Yes
M	1.3	AK Native	Other	Blood	Meningitis, osteomyelitis, cellulitis	a	None	Yes
F	1.3	AK Native	Other	Blood	Pneumonia	b	None	Yes
M	2.8	Non-Native	Anchorage	Blood	Pneumonia	f	None	Yes
M	3	AK Native	Other	Blood	Pneumonia	NT	None	Yes
M	31.7	Non-Native	Anchorage	Blood	Bacteremia	f	Immune suppressive treatment	Yes
M	45.7	AK Native	Anchorage	Blood	Pneumonia	NT	None	Yes
M	48.3	Non-Native	Other	Blood	Cellulitis	a	None	Yes
F	49.3	AK Native	Other	Blood	Bacteremia	NT	Smoking, alcohol abuse, diabetes	Yes
M	51.3	Non-Native	Other	Blood	Pneumonia	NT	None	Yes
M	51.8	Non-Native	Anchorage	Pleural fluid	Empyema, pneumonia	Unknown	Smoking, alcohol abuse	Yes
F	61.3	AK Native	Other	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	62.3	Non-Native	Other	Blood	Pneumonia	NT	None	Yes
M	63.7	Non-Native	Other	Blood	Pneumonia	NT	Smoking, chronic lung disease, alcohol abuse	Yes
M	66.4	AK Native	Other	Blood	Pneumonia	NT	Chronic lung disease	No
F	66.6	Non-Native	Anchorage	Blood	Bacteremia	NT	Smoking	No
M	73.8	AK Native	Anchorage	Blood	Septic arthritis, cellulitis	f	Diabetes	Yes
M	74.5	Non-Native	Other	Blood	Pneumonia	NT	Chronic lung disease, diabetes	Yes
M	77.1	AK Native	Other	Blood	Pneumonia	b	Chronic lung disease	Yes
F	78	Non-Native	Other	Blood	Pneumonia	NT	Immune suppressive treatment	Yes
M	80.4	AK Native	Other	Blood	Pneumonia	NT	Smoking, chronic lung disease	Yes
M	89.7	Non-Native	Anchorage	Blood	Bacteremia	Unknown	Diabetes	No

*NT = non-typeable

Invasive *Neisseria meningitidis*

Overall Incidence

One case of invasive *Neisseria meningitidis* was reported to AIP in 2010 for an overall rate of 0.1/100,000. The Alaska rate is similar to the ABCs 2010 national projected rate of 0.15/100,000 [9]. There were no invasive *N. meningitidis*-related deaths in Alaska in 2010.

Case Summary

The single case of *N. meningitidis* in 2010 occurred in a non-Native female child less than two years old whose residence was in the Anchorage area. The primary clinical presentation, determined by a review of the discharge diagnoses in the patient's medical record associated with the invasive bacterial illness, was septic arthritis. The culture was isolated from blood and was a serogroup W.

Race

The rate of invasive *N. meningitidis* in 2010 for non-Native children less than two years old was 6.7/100,000.

Invasive group A *Streptococcus*

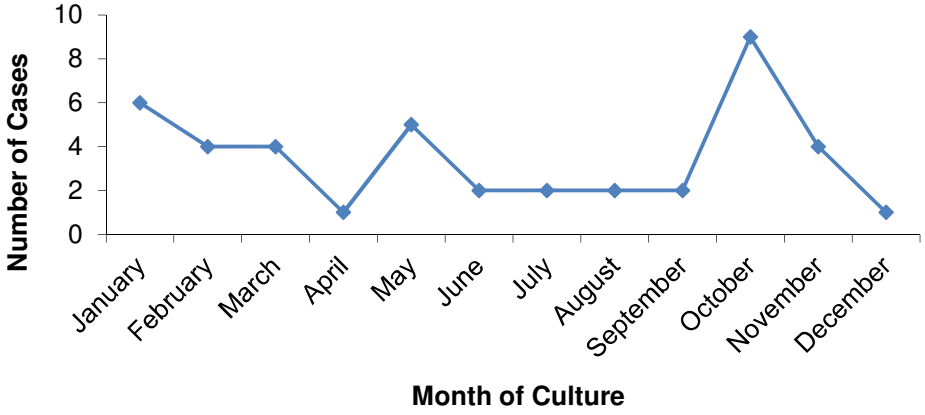
Overall Incidence

A total of 42 cases of invasive group A *Streptococcus* (GAS) were reported to AIP in 2010. The overall rate of invasive GAS disease in the state of Alaska was 5.9/100,000 persons per year. The Alaska rate is higher than the ABCs 2010 national projected rate of 4/100,000 [10]. In 2010, there were 7 GAS-related deaths for a case fatality ratio of 17%.

Seasonality

Cases of group A *Streptococcus* occurred throughout the year in 2010 with no apparent trends in seasonality.

Figure 15: Invasive group A *Streptococcus*, by Month of Culture - Alaska, 2010



Race

In 2010, 29% of invasive GAS cases in Alaska occurred in the Alaska Native population for an age-adjusted rate of 9.6/100,000 persons per year which was almost two times higher than the non-Native age-adjusted rate of 5/100,000 persons per year.

Table 16: Invasive group A *Streptococcus* Cases by Race – Alaska, 2010

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	12 (29%)	9.6	42%	1 (8%)
Non-Native	30† (71%)	5	50%	6 (20%)
Total	42		48%	7 (17%)

*Cases per 100,000 per percent distribution of Alaska 2010 population
†Includes one case for which race is unknown

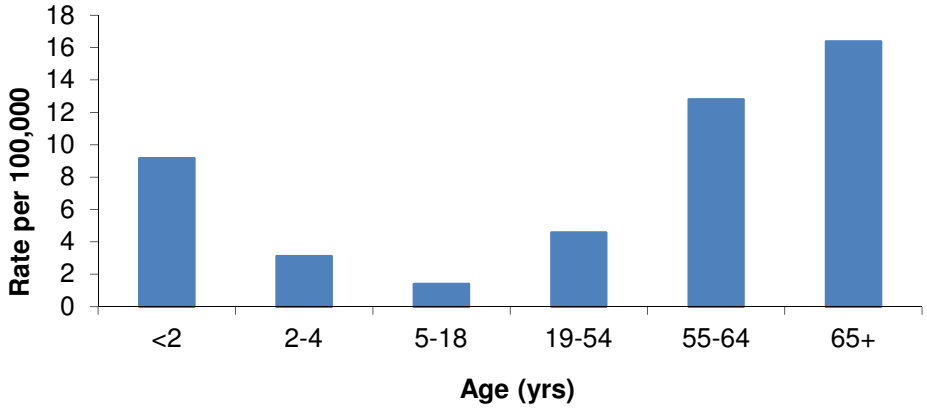
Region

Twenty-six (62%) of the 42 invasive group A *Streptococcus* cases in 2010 were reported in the Anchorage area, 6 cases in Southeast, 5 cases in the Interior, 3 cases in the YK Delta, and one case each in the North Slope and Norton Sound.

Age

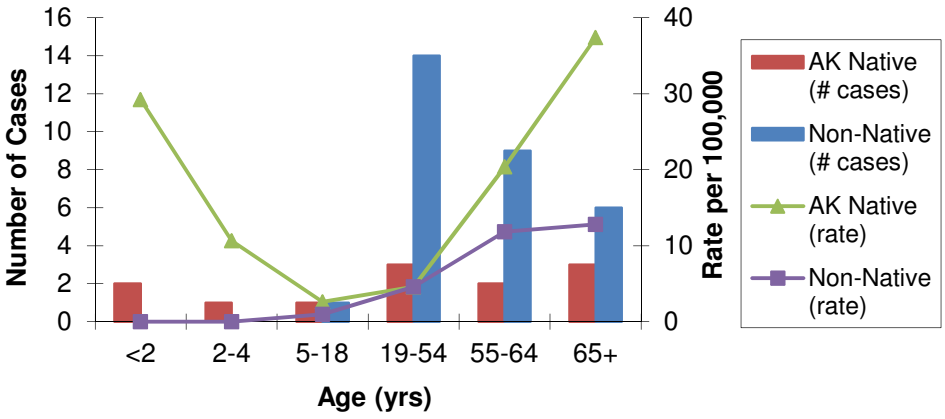
Invasive group A *Streptococcus* cases reported in 2010 ranged in age from 10 months to 85 years old; the median age was 54.6 years. Highest rates of disease occurred in adults 65 years and older (16.4/100,000).

Figure 16: Invasive group A *Streptococcus* by Age Group - Alaska, 2010



When stratified by race, the highest rates of invasive group A streptococcal disease occurred in Alaska Native adults 65 years and older (37.4/100,000 persons per year). The highest GAS disease rate in the non-Native population also occurred in adults 65 and older (12.8/100,000 persons per year).

Figure 17: Invasive group A *Streptococcus*, Cases & Rates by Age Group & Race - Alaska, 2010



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GAS infection was recorded as the primary clinical presentation. Table 17 shows the primary clinical presentations of invasive group A *Streptococcus* in Alaska for 2010. Eight cases also presented with secondary diagnoses including pneumonia and cellulitis.

Group A *Streptococcus* was isolated from blood samples in 36 (86%) of 42 cases, two each from joint fluid and cerebrospinal fluid, and one each from pleural fluid and a surgical specimen.

Table 17: Primary Clinical Presentations of Invasive group A *Streptococcus* – Alaska, 2010

Primary Presentation	n (%)
Cellulitis*	16 (38%)
Bacteremia	6 (14%)
Pneumonia*	6 (14%)
Septic arthritis	4 (10%)
Strep toxic shock	3 (7%)
Endocarditis	2 (5%)
Meningitis	2 (5%)
Necrotizing fasciitis	2 (5%)
Empyema	1 (2%)
Total	42

*with bacteremia

Table 18: Summary of Invasive group A *Streptococcus* Case Characteristics, Alaska, 2010

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	*emm* Type	Associated Medical Conditions	Survived
M	0.9	AK Native	Other	Blood	Cellulitis	82	None	Yes
F	0.9	AK Native	Other	Blood	Pneumonia	82	None	Yes
M	4.6	AK Native	Other	Blood	Cellulitis	89	None	Yes
M	10	Non-Native	Other	Blood	Septic arthritis	28	None	Yes
F	11	AK Native	Anchorage	Blood	Cellulitis	82	None	Yes
F	19.3	AK Native	Other	Blood	Cellulitis	39	Chronic lung disease	Yes
M	19.3	Non-Native	Anchorage	Blood	Cellulitis	82	None	Yes
M	27.8	Non-Native	Anchorage	Joint fluid	Septic arthritis, cellulitis	ND	None	Yes
F	28.1	Non-Native	Other	Pleural fluid	Empyema, pneumonia	1	None	Yes
M	30.9	Non-Native	Anchorage	Blood	Pneumonia	1	None	Yes
F	31	Non-Native	Anchorage	Blood	Cellulitis	82	Smoking	Yes
F	31.2	AK Native	Anchorage	Blood	Bacteremia	58	Injection drug use	Yes
M	31.9	AK Native	Other	Joint fluid	Septic arthritis	ND	Smoking	Yes
F	34.5	Non-Native	Anchorage	Blood	Cellulitis	ND	Unknown	Yes
F	34.6	Non-Native	Anchorage	Blood	Cellulitis	2	None	Yes
M	39.2	Unknown	Anchorage	Blood	Cellulitis	ND	Smoking	Yes
F	40.6	Non-Native	Anchorage	CSF	Meningitis	1	None	Yes
F	41.2	Non-Native	Other	Blood	STSS	ND	None	Yes
M	50.2	Non-Native	Other	Blood	STSS, pneumonia	ND	None	Yes
F	50.5	Non-Native	Other	Blood	Bacteremia	89	None	No
M	54.3	Non-Native	Other	Blood	Necrotizing fasciitis	25	Injection drug use	Yes
F	54.9	Non-Native	Anchorage	Blood	Endocarditis	89	Chronic lung disease	Yes
F	56.3	AK Native	Anchorage	Blood	Endocarditis, cellulitis	89	Chronic lung disease, alcohol abuse	Yes
F	56.4	Non-Native	Anchorage	Blood	Cellulitis	89	Smoking, chronic lung disease, alcohol abuse	No
F	57.4	Non-Native	Anchorage	Blood	Pneumonia	1	Chronic lung disease, diabetes	Yes
M	57.9	Non-Native	Anchorage	Blood	Cellulitis	ND	None	Yes
F	58.9	Non-Native	Anchorage	Blood	Cellulitis	82	Chronic lung disease	Yes
M	59.8	Non-Native	Other	Blood	Cellulitis	ND	Diabetes	No
M	60.2	Non-Native	Anchorage	Blood	Cellulitis	12	Alcohol abuse	No
M	62.6	AK Native	Anchorage	Blood	Pneumonia	82	Smoking, alcohol abuse	Yes
M	63.5	Non-Native	Anchorage	Blood	Bacteremia	ND	Smoking	Yes
F	64.2	Non-Native	Other	CSF	Meningitis	77	Chronic lung disease, diabetes	Yes
F	64.7	Non-Native	Other	Blood	STSS, pneumonia	1	Chronic lung disease	No
F	65.9	Non-Native	Anchorage	Blood	Pneumonia	82	Chronic lung disease, diabetes	Yes
M	68.2	Non-Native	Anchorage	Blood	Cellulitis	89	Diabetes	Yes
M	68.8	Non-Native	Other	Blood	Cellulitis	1	Diabetes	Yes
M	72.5	Non-Native	Anchorage	Blood	Bacteremia	82	Immune suppressive tx, diabetes	No
F	74.3	Non-Native	Anchorage	Blood	Septic arthritis	st2911	None	Yes
F	75.3	AK Native	Other	Blood	Bacteremia	108	Chronic lung disease, immune suppressive tx	No
M	78.2	Non-Native	Anchorage	Blood	Pneumonia	4	Chronic lung disease, immune suppressive tx	Yes
F	84.2	AK Native	Anchorage	Blood	Bacteremia	ND	Chronic lung disease	Yes
M	85	AK Native	Anchorage	Tissue	Necrotizing fasciitis	82	Chronic lung disease, diabetes	Yes

STSS = Streptococcal toxic shock syndrome
ND = typing not done

Invasive group B *Streptococcus*

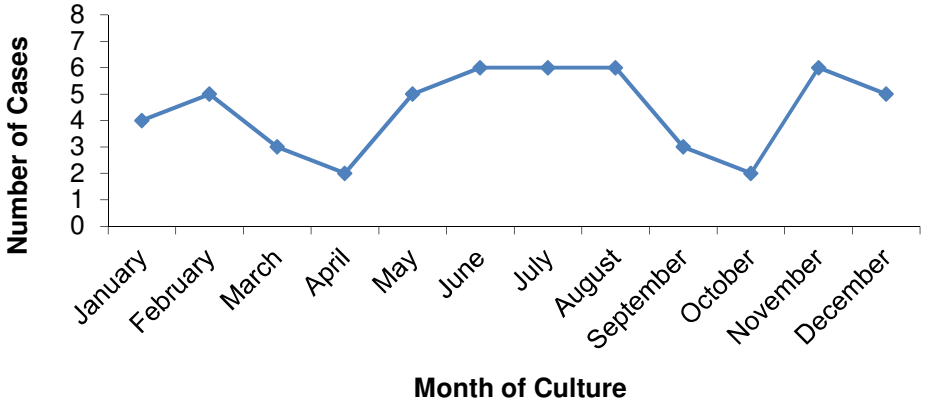
Overall Incidence

A total of 53 cases of invasive group B *Streptococcus* (GBS) were reported to AIP in 2010. The overall rate of invasive GBS disease in the state of Alaska was 7.5/100,000 persons per year. The Alaska rate is lower than the ABCs 2010 national projected rate of 8/100,000 [11]. In 2010, there were four GBS-related deaths for a case fatality ratio of 7.6%.

Seasonality

Cases of group B *Streptococcus* occurred throughout the year with no apparent trends in seasonality.

Figure 18: Invasive group B *Streptococcus*, by Month of Culture - Alaska, 2010



Race

In 2010, 26% of invasive group B *Streptococcus* cases in Alaska occurred in the Alaska Native population; the age-adjusted rate was 8/100,000 persons per year which is slightly higher than the non-Native rate of 7.3/100,000 persons per year.

Table 19: Invasive group B *Streptococcus* Cases by Race – Alaska, 2010

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	11 (26)	8	36	2 (18.2)
Non-Native	42 (74)‡	7.3	55	2 (4.8)
Total	53		51	4 (7.6)

*Cases per 100,000 per percent distribution of Alaska 2010 population
‡Includes one case for which race was unknown

Region

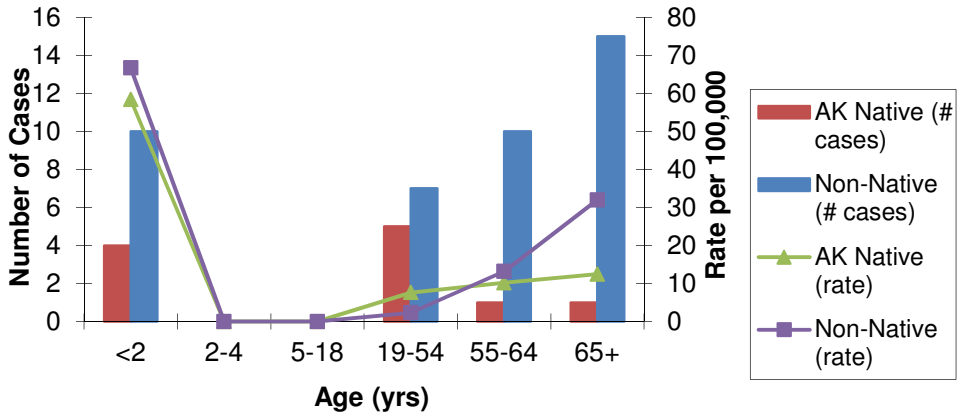
In 2010, 42 (79%) of the 53 reported GBS cases occurred in Anchorage; five cases were reported in Southeast Alaska, three cases in the YK Delta, two cases in the North Slope and one in the Interior.

Age

Invasive group B *Streptococcus* cases reported in 2010 ranged in age from newborn to 94.2 years old; the median age was 55.5 years. Highest rates of disease overall occurred in children less than two years old (64.1/100,000 persons per year).

Figure 19: Invasive group B *Streptococcus* by Age Group - Alaska, 2010

Figure 20: Invasive group B S*treptococcus*, Cases & Rates by Age Group & Race - Alaska, 2010



When stratified by race, the highest rates of disease occurred in non-Native children less than 2 years of age (66.7/100,000 persons per year). There were six cases of early-onset disease (less than 7 days old) for a rate of 0.6/1,000 live births.

Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GBS infection was recorded as the primary clinical presentation. In 2010, the most common clinical presentation was bacteremia which occurred in 28 cases (53%).

Group B *Streptococcus* was isolated from blood in 47 (89%) of 31 cases in 2010; four cases were isolated from joint fluid and two cases from cerebrospinal fluid.

Table 20: Primary Clinical Presentations of Invasive group B *Streptococcus* – Alaska, 2010

Primary Presentation	n (%)
Bacteremia	28 (53%)
Cellulitis*	7 (13%)
Septic arthritis	5 (9%)
Pneumonia*	4 (8%)
Meningitis	3 (5.5%)
Endocarditis	3 (5.5%)
Peritonitis	2 (4%)
Osteomyelitis	1 (2%)
Total	53

*with bacteremia

Antibiotic Resistance

Susceptibility testing was performed on 42 GBS isolates received in 2010. Results of the testing are presented in the following table.

Table 21: Antibiotic Resistance in Invasive group B *Streptococcus* Isolates – Alaska, 2010

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Ceftriaxone	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Erythromycin	21 (50%)	0 (0%)	21 (50%)	21 (50%)	42
Tetracycline	6 (14%)	0 (0%)	36 (86%)	36 (86%)	42
Levofloxacin	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42
Clindamycin	31 (74%)	0 (0%)	11 (26%)	11 (26%)	42
Vancomycin	42 (100%)	0 (0%)	0 (0%)	0 (0%)	42

All isolates tested were susceptible to penicillin, ceftriaxone, levofloxacin and vancomycin. Resistance to tetracycline, erythromycin and clindamycin was seen in 86%, 50% and 26%, respectively, of isolates tested. Of the six early onset cases, four isolates were available for susceptibility testing. All four isolates tested were resistant to tetracycline; one isolate was also resistant to erythromycin and one isolate was also resistant to erythromycin and clindamycin.

Table 21: Summary of Invasive group B *Streptococcus* Case Characteristics, Alaska, 2010

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Associated Medical Conditions	Survived
F	Newborn	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	Newborn	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	Newborn	Non-Native	Anchorage	Blood	Pneumonia	None	Yes
M	Newborn	Non-Native	Other	Blood	Bacteremia	None	Yes
M	1 day	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	1 day	Non-Native	Other	Blood	Bacteremia	None	Yes
M	22 days	Unknown	Anchorage	Blood	Bacteremia	None	Yes
F	22 days	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	26 days	Non-Native	Anchorage	CSF	Meningitis	None	Yes
F	29 days	AK Native	Other	CSF	Meningitis	None	No
M	36 days	AK Native	Other	Blood	Pneumonia	None	Yes
F	40 days	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	69 days	AK Native	Anchorage	Blood	Cellulitis	None	Yes
M	1.2	AK Native	Other	Blood	Bacteremia	None	Yes
F	21.6	AK Native	Other	Blood	Bacteremia	None	Yes
F	23.9	Non-Native	Other	Blood	Bacteremia	Smoking	Yes
F	28.9	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	31.1	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	31.7	AK Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
M	41.5	AK Native	Anchorage	Blood	Osteomyelitis	Smoking, diabetes	Yes
M	43	Non-Native	Anchorage	Blood	Bacteremia	Smoking, diabetes	Yes
F	43.4	AK Native	Other	Blood	Bacteremia	Smoking, diabetes	Yes
M	44.3	Non-Native	Anchorage	Blood	Septic arthritis	Diabetes	Yes
M	44.8	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	45.1	Non-Native	Anchorage	Blood	Peritonitis	Smoking, alcohol abuse	Yes
M	52.3	AK Native	Anchorage	Blood	Bacteremia	Smoking, chronic lung disease, alcohol abuse	Yes
M	55.5	Non-Native	Anchorage	Joint fluid	Septic arthritis	Smoking	Yes
F	56.2	Non-Native	Anchorage	Blood	Endocarditis	None	No
F	56.6	Non-Native	Other	Joint fluid	Septic arthritis	Unknown	Yes
F	56.7	AK Native	Anchorage	Blood	Cellulitis	Chronic lung disease	Yes
F	57.8	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	58.5	Non-Native	Anchorage	Blood	Bacteremia	Smoking	Yes
F	60.1	Non-Native	Anchorage	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
M	60.3	Non-Native	Anchorage	Blood	Bacteremia	Diabetes	Yes
M	60.4	Non-Native	Anchorage	Joint fluid	Septic arthritis	None	Yes
M	60.9	Non-Native	Anchorage	Joint fluid	Septic arthritis	None	Yes
M	63.7	Non-Native	Anchorage	Blood	Endocarditis, pneumonia	None	Yes
F	65.2	Non-Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
F	65.2	Non-Native	Anchorage	Blood	Bacteremia	Immune suppressive tx	Yes
M	65.8	Non-Native	Anchorage	Blood	Pneumonia, cellulitis	None	Yes
F	66.6	Non-Native	Other	Blood	Peritonitis	Immune suppressive tx, diabetes	No
M	68.2	Non-Native	Anchorage	Blood	Endocarditis	Diabetes	Yes
M	68.3	Non-Native	Anchorage	Blood	Pneumonia	Smoking, chronic lung disease	Yes
F	70	Non-Native	Anchorage	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
M	76.3	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
M	77.7	Non-Native	Anchorage	Blood	Meningitis	Diabetes	Yes
M	77.7	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
F	78.2	Non-Native	Anchorage	Blood	Cellulitis	None	Yes
M	81.9	Non-Native	Other	Blood	Bacteremia	None	Yes
M	85.9	Non-Native	Anchorage	Blood	Bacteremia	Immune suppressive tx	Yes
M	88.4	Non-Native	Anchorage	Blood	Bacteremia	Chronic lung disease, diabetes	Yes
F	89.4	Non-Native	Anchorage	Blood	Cellulitis	Diabetes	Yes
F	94.2	AK Native	Anchorage	Blood	Bacteremia	None	No

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Appendix

MIC Interpretive Standards Definitions:

CLSI [5] provides recommended interpretive categories for various Minimum Inhibitory Concentration values (cut points) for each organism/antibiotic combination which are defined as follows:

1. Susceptible (S):

The "susceptible" category implies that isolates are inhibited by the usually achievable concentrations of antimicrobial agent when the recommended dosage is used for the site of infection.

2. Intermediate (I):

The "intermediate" category includes isolates with antimicrobial agent MICs that approach usually attainable blood and tissue levels and for which response rates may be lower than for susceptible isolates. The "intermediate" category implies clinical efficacy applicability in body sites where the drugs are physiologically concentrated (e.g., quinolones and β-lactams in urine) or when a higher dosage of a drug can be used (e.g., β-lactams). The "intermediate" category also includes a buffer zone which should prevent small, uncontrolled technical factors from causing major discrepancies in interpretations, especially for drugs with narrow pharmacotoxicity margins.

3. Resistant (R):

Resistant strains are not inhibited by the usually achievable concentrations of the agent with normal dosage schedules, and/or that demonstrate MICs or zone diameters that fall in the range where specific microbial resistance mechanisms are likely (e.g., β-lactamases) are likely, and clinical efficacy of the agent against the isolate has not been reliably shown in treatment studies.